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Robot-Assisted Surgery for Cervical Cancer: A Systematic Review of Clinical Outcomes

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Abstract

Background: Robot-assisted surgery is used for invasive cervical cancer but pooled minimally invasive evidence does not isolate the robotic platform's outcomes.

Objective: To synthesize perioperative, pathologic, oncologic, and recovery outcomes reported after robot-assisted surgery for invasive cervical cancer.

Methods: Clinical studies (2011–2026) reporting separable robotic outcomes were eligible. PubMed, Embase, Google Scholar, and LILACS exports were screened according to PRISMA 2020. Case reports, reviews, meta-analyses, protocols without results, and studies lacking separable robotic data were excluded. One reviewer assessed risk of bias with design-specific Joanna Briggs Institute (JBI) tools and evidence certainty with GRADE. Of 270 records, 5 duplicates were removed; 265 were screened, 58 full texts assessed, and 24 nonrandomized studies included after 34

full-text exclusions. Counts are reconstructed from supplied exports, not historical database yields. Synthesis was narrative, without meta-analysis.

Results: The 24 studies (2013–2025) were comparative cohorts or single-arm investigations. Some reported lower blood loss or shorter hospitalization; operative time, complications, lymph-node yield, and survival varied. Certainty was low for comparative blood loss and length of stay and very low for complications, pathologic and oncologic outcomes, recovery, and feasibility.

Conclusion: Evidence suggests possible perioperative benefits but does not establish oncologic equivalence or superiority over open surgery. Outcomes from studies combining robotic and conventional laparoscopy cannot be attributed to the robotic platform.

Keywords: Cervical Cancer, Robot-Assisted Surgery, Radical Hysterectomy, Survival, Perioperative Outcomes

1. Introduction

Radical hysterectomy with pelvic lymph-node assessment is a surgical treatment option for selected patients with early-stage invasive cervical cancer. The surgical route may affect perioperative morbidity and recovery, while complete tumor resection and appropriate nodal assessment remain central to oncologic management. Evaluation of a surgical approach therefore requires consideration of perioperative and cancer outcomes ^[1-3].

Robot-assisted surgery enables minimally invasive pelvic dissection using three-dimensional visualization and articulated instruments. These technical characteristics may facilitate operative maneuvers in the pelvis; however, they do not establish superior safety or cancer control. The clinical value of the robotic approach must be assessed through patient-level outcomes and comparison with other surgical routes ^[1-3].

The randomized Laparoscopic Approach to Cervical Cancer (LACC) trial reported lower disease-free survival (DFS) and overall survival (OS) after minimally invasive radical hysterectomy than after open surgery ^[1]. Its results concern minimally invasive surgery (MIS) as a category and do not provide a distinct estimate for robot-assisted surgery.

Population-based and multicenter observational studies, including the cohort reported by Melamed *et al.* and the European SUCCOR study, also raised concerns about outcomes after minimally invasive radical hysterectomy ^[2-3]. Because these studies did not separately identify outcomes for robotic and conventional laparoscopic procedures, they inform the broader comparison of surgical routes but do not determine the robot-specific effect.

Evidence varies across disease stage, treatment context, comparator, outcome definition, and follow-up; studies that analyze minimally invasive surgery as a single category do not isolate the effect of the robotic approach [1-3].

Accordingly, the objective of this systematic review was to synthesize original clinical studies of robot-assisted surgery for invasive cervical cancer, focusing on perioperative, pathologic, oncologic, and recovery outcomes and distinguishing robot-specific findings from results reported for minimally invasive surgery as a combined category [1-3]. The guiding question was: Among patients with invasive cervical cancer, what perioperative, pathologic, oncologic, and recovery outcomes are reported after robot-assisted surgery, and how do these outcomes compare with those after open surgery, conventional laparoscopy, or alternative robotic approaches? For single-arm studies, which outcomes are reported?

2. Methods

2.1 Review design and reporting

This systematic review synthesized original human clinical studies of robot-assisted surgery for invasive cervical cancer. Reporting was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [4]. No protocol or registration record was available in the supplied materials; prospective methods and protocol amendments could not be verified.

2.2 PICO Framework

Population (P): Patients with histologically confirmed invasive cervical carcinoma at preoperative diagnosis or surgery. Reports with no residual invasive carcinoma after diagnostic excision were eligible when they described a cohort diagnosed and treated for invasive cervical cancer and reported robotic outcomes.

Intervention (I): Robot-assisted procedures with separately identifiable outcomes, including robot-assisted radical hysterectomy (RRH), robotic trachelectomy, and robot-assisted sentinel lymph node (SLN) procedures.

Comparator (C): Open surgery, conventional laparoscopy, or an alternative robotic configuration or surgical period. A comparator was not required for single-arm studies.

Outcomes (O): Perioperative and postoperative outcomes, pathologic findings, recurrence, disease-free or overall survival, SLN detection, quality of life, and recovery or discharge outcomes.

2.3 Eligibility Criteria

Eligible reports were original human clinical studies published in English from 2011 through 2026 and providing patient-level clinical data. Eligible designs included comparative cohort and case-control studies, clinical series, prospective studies, and single-arm studies. Exclusion criteria were individual case reports, systematic or narrative reviews, meta-analyses, protocols without outcome data, editorials or letters without original clinical data, non-human or technical-only studies, other cancer sites or benign indications, preinvasive cervical lesions without documented invasive-cancer diagnosis, studies outside the publication period, and mixed minimally invasive cohorts without a separately extractable robotic result. Comparative case-control studies were classified as original clinical

studies and were not treated as case reports.

2.4 Information sources and search strategy

The information sources were supplied search-result exports from PubMed, Embase, Google Scholar, and the Latin American and Caribbean Health Sciences Literature (LILACS) database. The search was organized around invasive cervical neoplasms and robotic surgery. Controlled vocabulary included the Medical Subject Headings (MeSH) terms "Uterine Cervical Neoplasms" and "Robotic Surgical Procedures," corresponding Health Sciences Descriptors (DeCS) concepts where indexed, and Embase terms mapped to Emtree where available. English free-text terms covered cervical cancer, cervix cancer, cervical carcinoma or neoplasm, early-stage or locally advanced cervical cancer, robotic surgery, robot-assisted laparoscopy, robotic hysterectomy, robotic radical hysterectomy, and the da Vinci surgical system. Publication eligibility was restricted to English-language reports from 2011 through 2026. The final search dates and complete database-specific query histories were not retained in the supplied files.

For database-specific execution, concepts were mapped to MeSH and title/abstract fields in PubMed, Emtree and title/abstract/keyword fields in Embase, text phrases in Google Scholar, and DeCS plus free-text equivalents in LILACS. Synonyms within each concept were combined with OR, and the cervical-cancer and robotic-surgery concept blocks were combined with AND. Exclusion criteria were applied during screening rather than through NOT terms in the main query. The portable Boolean expression below documents the search concepts: ("Uterine Cervical Neoplasms" OR "uterine cervix cancer" OR "cervical cancer" OR "cervix cancer" OR "cervical carcinoma" OR "cervical neoplasm" OR "cervical neoplasms" OR "early-stage cervical cancer" OR "locally advanced cervical cancer" OR "cancer of the cervix") AND ("Robotic Surgical Procedures" OR "robot assisted surgery" OR "robotic surgery" OR "robot-assisted surgery" OR "robotic-assisted surgery" OR "robot assisted laparoscopy" OR "robot-assisted laparoscopy" OR "robotic hysterectomy" OR "robot-assisted hysterectomy" OR "robotic radical hysterectomy" OR "robot-assisted radical hysterectomy" OR "total robotic radical hysterectomy" OR "Da Vinci surgical system").

Because the source exports did not retain complete database-specific query histories, this expression is a transparent reconstruction of the concepts and cannot be verified as the exact syntax executed in each database. Search dates and historical hit totals therefore could not be reproduced from the available files.

2.5 Study Selection

Study selection proceeded in two stages. One reviewer screened titles and metadata against the eligibility criteria. Potentially eligible records were then assessed using available abstracts and accessible full texts. The source materials did not specify the number of reviewers who assessed full texts or document independent duplicate screening, adjudication, or automation tools. Full-text exclusions were grouped by reason, with counts reported in the Results and Fig 1. The flow diagram was reconstructed from the supplied exports and screening counts because

complete search logs and a record-level screening file were unavailable.

2.6 Data Collection

The available reports were reviewed and the following data items recorded: first author and year, study design, sample size, disease stage or treatment context, robotic procedure, comparator, follow-up, and reported perioperative, pathologic, oncologic, and recovery outcomes. The source materials did not identify the number of data extractors or document a piloted form, independent duplicate extraction, or contact with study investigators. Missing sample sizes or numerical results were not imputed and were marked as unavailable in Table 1.

2.7 Risk of bias and certainty of evidence

One reviewer appraised each report using JBI critical appraisal instruments matched to study design: the revised cohort tool for cohort studies [5], the JBI checklist for case-control studies [6], the case-series tool for uncontrolled observational series [7], and the revised quasi-experimental tool for prospective nonrandomized intervention studies when applicable [8]. Appraisal considered participant selection, exposure or intervention classification, comparability and confounding, outcome ascertainment, follow-up and retention, and statistical analysis. Item-level judgements were recorded as yes, no, unclear, or not applicable, as appropriate. Findings are presented by domain without summing checklist items into an overall numerical score. The appraisal was conducted by one reviewer, without independent duplicate assessment or a consensus procedure.

Potential selective reporting was considered narratively from the consistency of reported outcomes and the availability of prespecified protocols or registry records; where these materials were unavailable, selective reporting was judged unclear. Statistical tests for publication bias were not applied because the studies were heterogeneous and no meta-analysis was conducted. Certainty was assessed qualitatively by outcome domain using GRADE, considering risk of bias, inconsistency, indirectness, imprecision, and publication bias. The nonrandomized evidence began at low certainty; ratings were downgraded where warranted, and no upgrade was applied [9].

2.8 Data synthesis and presentation

Study characteristics and findings were tabulated and synthesized narratively within the following domains: perioperative outcomes; oncologic outcomes; locally advanced disease and neoadjuvant treatment; learning-curve effects; recovery and quality of life; robotic-versus-laparoscopic comparisons; and sentinel-node procedural feasibility. Differences in study design, populations, comparators, outcome definitions, and follow-up precluded

quantitative pooling. Accordingly, no meta-analysis, pooled effect estimates, heterogeneity statistics, subgroup or sensitivity analyses, or tests for reporting bias were performed. Results are presented as reported in the source studies; unreported outcome values were not derived.

3. Results

The searches in PubMed, Embase, Google Scholar, and LILACS identified 270 records: 200 in PubMed, 30 in Embase, 20 in Google Scholar, and 20 in LILACS. After removal of five duplicate records, 265 unique records underwent title and metadata screening. At this stage, 207 records were excluded: 194 retrieved through PubMed, Embase, and Google Scholar combined and 13 from LILACS. The 13 LILACS records were excluded because they were reviews or meta-analyses ($n = 4$), case reports or clinical series that did not meet the eligibility criteria ($n = 3$), technical reports or records without separable cervical-cancer outcomes ($n = 4$), or records outside the eligible intervention or population ($n = 2$). The remaining 58 records underwent full-text eligibility assessment. Thirty-four were excluded for the following reasons: protocols without clinical results ($n = 4$), reviews or meta-analyses ($n = 4$), publication outside the review period ($n = 2$), a technical video without clinical outcome data ($n = 1$), and reports with an ineligible robotic outcome or unresolved citation metadata ($n = 23$). Twenty-four original clinical studies were included in the narrative synthesis (Fig 1).

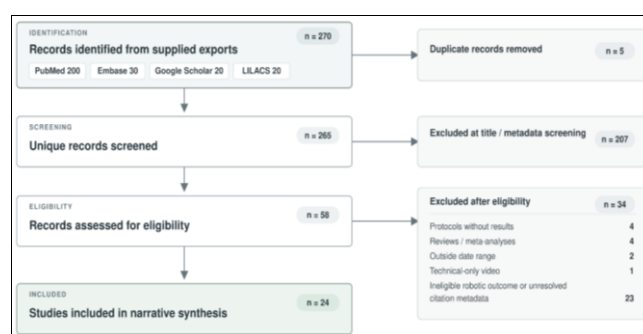


Fig 1: PRISMA-style flow of records database

The 24 included studies were published from 2013 to 2025. Most were observational cohorts or comparative studies; the set also included a prospective phase II study, a prospective multicenter single-arm trial, a 2025 prospective pilot, and prospective feasibility studies. Comparators included open surgery, laparoscopy, alternate robotic configurations, sentinel-node detection devices, or within-robotic cohorts. Several studies examined selected patients treated after neoadjuvant chemotherapy (NACT) or chemoradiation, learning curves, or enhanced recovery rather than comparative cancer-control effects. Study characteristics and findings are summarized in Table 1 [10-33].

Table 1: Characteristics and reported findings of the 24 included studies

Study	Design and Population	Reported Robotic Findings
[10] Vitobello, 2013	Comparative cohort; 46 total (25 early-stage, 21 locally advanced; 18 locally advanced patients underwent robotic surgery after neoadjuvant chemotherapy).	Perioperative outcomes and pathologic measures were comparable between the robotic groups. The small cohort did not establish long-term survival outcomes.
[11] Vizza, 2014	Retrospective multicenter cohort; 60 patients with FIGO IB2-IIB disease after neoadjuvant chemotherapy.	Median operative time was 225 min and blood loss 150 mL; 19 postoperative complications and 6 transfusions were reported. At median follow-up of 28.9 months, 83% were recurrence-free.
[12] Kim, 2015	Retrospective comparative cohort; 63 patients in the final analysis (34 total laparoscopic, 29 total robotic radical hysterectomy).	Robotic surgery was associated with lower blood loss and more pelvic nodes retrieved, but longer operative time. Short-term health-related quality of life did not differ significantly.
[13] Asciutto, 2015	Swedish registry cohort; 249 patients (64 robotic, 185 open).	Robotic surgery was associated with lower blood loss, shorter stay (2.1 vs 6.1 days), and faster return to daily activities (9.7 vs 13.4 days). No robotic patient received transfusion; 7% of open patients did.
[14] Vizza, 2015	Comparative study after neoadjuvant chemotherapy; 25 robotic procedures versus 25 historical laparoscopic controls.	Median operative time was 190 min in both groups. Blood loss favored the robotic group; hospital stay was 4 versus 6 days ($P = .28$). Complication differences were not statistically significant.
[15] Sert, 2016	Retrospective multicenter cohort; 491 patients (259 robotic, 232 open).	The robotic group had more favorable perioperative measures, including blood loss, transfusion, and length of stay. Recurrence and survival were reported as comparable; residual confounding is possible.
[16] Gallotta, 2017	Prospective phase II study; 40 patients with locally advanced disease after concomitant chemoradiation.	Thirty-nine patients completed robotic surgery. Median operative time was 185 min, median blood loss 100 mL, and 9 patients had postoperative complications. Five recurrences were reported at a median follow-up of 18 months.
[17] Shah, 2017	Retrospective two-center cohort; 311 patients (109 robotic, 202 open).	Robotic surgery was associated with lower blood loss (105.9 vs 482.6 mL), shorter stay (42.7 vs 112.6 h), and fewer complications (9.2% vs 23.4%). Recurrence rates were similar (10.1% vs 10.4%); adjusted PFS and OS differences were not significant.
[18] Yim, 2018	Comparative cohort; 142 robotic procedures comparing three-arm and four-arm configurations.	Three-arm surgery was associated with less postoperative pain. Operative time, length of stay, and complications were otherwise comparable.
[19] Matanes, 2019	Retrospective single-center cohort; 98 patients (74 robotic, 24 open).	Robotic surgery was associated with shorter hospital stay (1 vs 7 days), lower estimated blood loss, and fewer postoperative complications. The study reported no worse oncologic outcomes in the robotic cohort.
[20] Alfonzo, 2019	Nationwide population-based cohort; 864 patients (628 robotic, 236 open); propensity-matched groups of 232 each.	After matching, five-year overall survival was 92% in both groups; disease-free survival was 85% open versus 84% robotic, with no significant difference.
[21] Eoh, 2020	Retrospective cohort; 310 patients (142 open, 168 robotic) with early-stage disease.	The institutional robotic learning curve and surgical period were associated with oncologic outcomes. Later robotic experience showed more favorable progression-free survival patterns.
[22] Yang, 2020	Retrospective cohort; 333 patients (181 open, 152 robotic).	Five-year PFS was 79.0% with robotic versus 90.5% with open surgery (HR 2.37, 95% CI 1.40–4.02); five-year OS was 85.8% versus 95.3% (HR 3.17, 95% CI 1.76–5.70).
[23] Paek and Lim, 2021	Retrospective cohort; 64 patients undergoing robotic radical hysterectomy for stage IB disease.	Recurrence was associated with the early surgical period and tumor size, supporting caution when interpreting results from an early learning phase.
[24] de Bruyn, 2021	Observational cohort; 166 patients with FIGO 2009 stage IA1-IB1 treated robotically.	Twenty-one recurrences were reported. The reported five-year disease-free and overall survival estimates were 85% and 91%, respectively.
[25] Baeten, 2021	Observational cohort; 165 patients with early-stage disease.	Five-year disease-free survival was 80.2% during the learning phase and 91.1% after experience ($P = .040$). The finding is from a single-center observational cohort.
[26] Paek and Lim, 2022	Retrospective ERAS cohort; 94 robotic radical hysterectomies.	Seventy-two patients were discharged within 12 hours. Complications and unexpected visits did not differ significantly by early-discharge status.
[27] Li, 2022	Multicenter retrospective cohort; 1,137 patients (468 robotic, 669 open).	Overall three-year overall survival and disease-free survival did not differ significantly. In adjusted analyses, robotic surgery was associated with lower disease-free survival (matched HR 2.498, 95% CI 1.123–5.557).
[28] Ito, 2024	Prospective multicenter single-arm interventional trial; 100 patients underwent robotic surgery.	The prespecified blood-loss and negative-margin endpoint was met in 89 patients. At median observation of 37 months, reported two-year recurrence-free and overall survival were 82.7% and 96.9%; interim single-arm findings are not comparative evidence.
[29] Yim, 2014	Retrospective comparative cohort; 102 patients (60 robotic and 42 conventional laparoscopic radical hysterectomies).	Estimated blood loss was lower with robotic surgery (100 vs 145 mL; $P = .037$), as were early postoperative complications (16.7% vs 30.9%; $P = .028$). Operative time, lymph-node yield, and hospital stay were comparable; median follow-up was 44 months.
[30] Baeten, 2022	Prospective, single-center, single-arm feasibility study; 10 patients undergoing robot-assisted sentinel lymph node procedures.	At least one sentinel node was detected in every patient; bilateral detection with the drop-in gamma probe was 80%. Twenty-one of 22 nodes seen on SPECT/CT were identified intraoperatively, including all tumor-positive nodes; no procedure-related adverse events were reported.
[31] Ponce, 2020	Multicenter retrospective cohort; 239 women with early-stage cervical cancer treated with robotic radical hysterectomy.	After median follow-up of 51 months, 26 patients (10.9%) had recurrence. Tumor size >20 mm, adenocarcinoma, positive pelvic nodes, higher tumor grade, and no sentinel lymph node biopsy were associated with recurrence.

[32] Chang, 2020	Retrospective cohort; 805 consecutive patients undergoing robotic radical hysterectomy, including 244 after neoadjuvant chemotherapy.	Perioperative and severe complication rates were 45.09% and 7.83%. Neoadjuvant chemotherapy was associated with higher odds of perioperative complications (OR 11.08, 95% CI 5.70-21.54), without a statistically significant difference in severe complications.
[33] Oplawski, 2025	Prospective single-center pilot; 20 patients, FIGO IA2–IIA1; 4 robotic radical hysterectomies, 12 TMMR procedures, and 4 trachelectomies. The report describes invasive cancer at enrollment but also lists HSIL/in situ in 15/20 histopathology records.	All procedures were completed robotically; mean operative time was 178 min, mean blood loss 112 mL, and 2 minor complications were reported. No recurrence was reported, but follow-up is inconsistent within the article (24 months in the text versus 12.0 ± 0.5 months and recurrence within 12 months in Table 2). A fatal postoperative hemorrhage occurred outside the final analytic cohort and led to suspension of recruitment.

Legend: CI, confidence interval; ERAS, enhanced recovery after surgery; FIGO, International Federation of Gynecology and Obstetrics; HR, hazard ratio; HSIL, high-grade squamous intraepithelial lesion; OR, odds ratio; SPECT/CT, single-photon emission computed tomography/computed tomography; TMMR, total mesometrial resection.

No randomized trial was included. Comparative evidence was observational, and the most recurrent concern was confounding from patient selection, treatment indication, center or surgeon experience, and calendar period [10-15, 17, 19-23, 25, 27, 29, 32]. Comparability was particularly limited when cohorts differed by stage or treatment response, as in the post-neoadjuvant cohort [10], when baseline treatment and stage were imbalanced without adjustment [12], or when historical controls were used [14, 19]. Robotic availability was concentrated in one center in the registry study [13], while propensity matching in the nationwide cohort reduced measured differences but could not address residual confounding related to center-level availability [20]. Adjustment in several cohorts [15, 17, 20, 27, 32] improves control of measured factors but does not remove these design constraints. Learning-curve and surgical-era effects were closely linked in several reports [21, 23, 25]; the robotic configuration groups also reflected different treatment periods [18].

Selection, attrition, and outcome measurement raised additional concerns. Of 224 records reviewed in the three-arm versus four-arm study, 82 were excluded, including patients with incomplete clinical or follow-up data [18]. The BGOG cohort excluded 104 of 270 patients from the analyzed population and omitted 24 patients upstaged after surgery from recurrence analyses [24]; a similar post-surgical exclusion affected the recurrence analysis in the robotic risk-factor cohort [31]. In the ERAS study, early discharge depended on postoperative clinical status, and later urinary symptoms were self-reported [26]. The prospective multicenter study used prespecified feasibility endpoints but had no concurrent comparator [28], and the sentinel-node feasibility study included only ten patients [30]. Single-arm reports after neoadjuvant chemotherapy or chemoradiation likewise describe selected populations and do not estimate comparative effects [11, 16].

The Oplawski pilot had no comparator and included 20 patients. The article reports that a fatal postoperative hemorrhage occurred outside the final analytic cohort and led to suspension of recruitment; this event therefore is not reflected in the final-cohort complication rate [33]. The same report states that all patients completed 24-month follow-up, while Table 2 lists mean follow-up of 12.0 ± 0.5 months and recurrence within 12 months; it also reports HSIL/in situ lesions in 15 of 20 histopathology records despite describing

invasive cervical cancer at enrollment [33]. These inconsistencies increase concern about outcome reporting and applicability. In the other prospective single-arm studies, design features such as a defined feasibility endpoint [28] support descriptive interpretation, but small samples and lack of a comparator remain consequential [16, 28, 30].

Using GRADE, certainty remained low for comparative perioperative blood loss and length of stay: the direction of findings was broadly similar across several sizeable cohorts, but residual confounding and outcome heterogeneity preclude higher certainty. Certainty was very low for complications, pathologic outcomes, recurrence and survival, recovery or quality-of-life outcomes, and procedural feasibility because of residual confounding, inconsistent findings, limited or unequal follow-up, sparse events, indirectness, and the contribution of uncontrolled small studies. These are qualitative outcome-level ratings; no pooled estimates were available [5, 7-9].

The annual distribution of papers included is shown in Fig 2. Three studies were published in 2015, four in 2020, and three each in 2021 and 2022; the distribution describes the selected records and should not be interpreted as a measure of the field's annual publication rate.

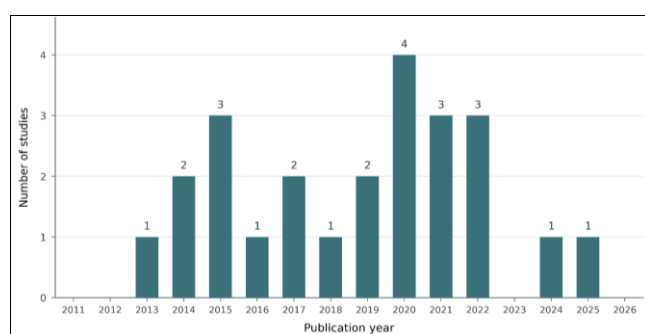


Fig 2: Included studies by publication year

The evidence set comprised 7 robotic-versus-open comparisons, 3 robotic-versus-laparoscopic comparisons, 12 robotic-cohort or within-cohort analyses, 1 robot-assisted procedural feasibility study, and 1 comparison of robotic arm configurations (Fig 3). These mutually exclusive categories describe each study's principal comparison frame, not its evidential weight.

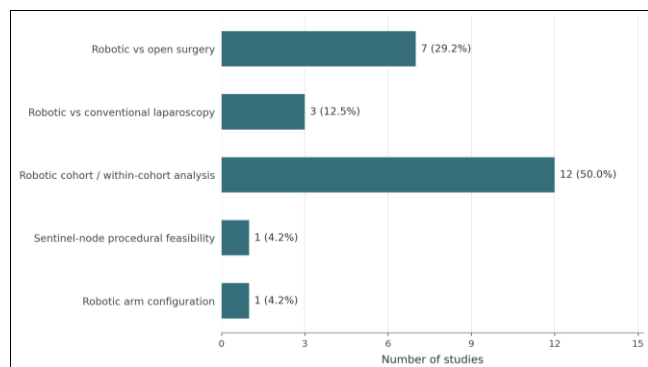


Fig 3: Principal comparison frame of the included studies

Table 2: Narrative synthesis by clinical outcome domain

Outcome Domain	Evidence Pattern	Context for Interpretation
Perioperative outcomes	Several robotic-versus-open cohorts reported lower blood loss, shorter hospital stay, or fewer perioperative complications [13, 15, 17, 19]. Yim <i>et al.</i> reported lower blood loss and fewer early complications versus laparoscopy [29]. The 2025 pilot reported mean blood loss of 112 mL and two minor postoperative complications [33].	These findings are observational and may reflect patient selection, center volume, surgical era, and perioperative pathways. Operative time and nodal yield were not consistent across comparisons [12-15, 29].
Oncologic outcomes	Survival findings were mixed. Some matched or adjusted cohorts found no statistically significant difference [15, 17, 19-20], whereas other cohorts reported poorer progression-free or disease-free survival [22, 27]. Ponce <i>et al.</i> identified recurrence-associated factors within a robotic cohort [31]. The 2025 pilot reported no recurrence, but its follow-up duration is inconsistent within the report [33].	The studies differ in staging, tumor characteristics, follow-up, adjuvant therapy, and analytic approach. Findings from single-arm cohorts do not provide comparative effect estimates.
Locally advanced disease	Studies after neoadjuvant chemotherapy or chemoradiation described robotic procedures in selected patients [10-11, 16]. Chang <i>et al.</i> evaluated perioperative complications among 805 patients, including 244 treated with neoadjuvant chemotherapy [32].	These results describe feasibility and perioperative safety; they do not establish comparative survival effectiveness after neoadjuvant treatment.
Learning curve	Institutional experience and the early robotic surgical period were associated with recurrence or disease-free survival in several cohorts [21, 23, 25].	Learning-curve effects may overlap with calendar time, staging, selection, tumor size, and changes in adjuvant care.
Recovery and quality of life	Registry and pathway studies reported faster return to daily activities or early discharge in some settings [13, 26]. A laparoscopic comparison found no short-term quality-of-life difference [12]; pain outcomes differed by robotic configuration [18].	Patient-reported outcomes and discharge criteria were not standardized across studies.
Robotic versus laparoscopic comparison	Comparative studies examined perioperative, nodal, and quality-of-life outcomes [12, 14, 29]. Yim <i>et al.</i> reported lower blood loss and fewer early postoperative complications with robotics [29].	These studies do not establish a general survival or quality-of-life advantage over conventional laparoscopy.
Sentinel-node procedural feasibility	Baeten <i>et al.</i> reported robot-assisted sentinel-node detection in 10 patients [30].	This study addresses procedural feasibility and early outcomes rather than comparative long-term cancer control.

4. Discussion

This systematic review synthesized 24 original clinical studies reporting outcomes attributable to robot-assisted procedures for invasive cervical cancer. The evidence covered comparisons with open or laparoscopic surgery, robotic cohorts, learning-curve analyses, recovery outcomes, and prospective feasibility studies. Several comparative studies reported perioperative advantages, while oncologic findings varied across cohorts and endpoints [10-33].

Lower blood loss and shorter hospital stay were reported in several robotic-versus-open cohorts [13, 15, 17, 19]. In the LILACS-derived comparative cohort by Yim *et al.*, estimated blood loss and early postoperative complications were lower with robotic than conventional laparoscopic radical hysterectomy, while operative time, lymph-node yield, and length of stay were similar [29]. In contrast, Chang *et al.* reported substantial perioperative morbidity in a large cohort undergoing robotic radical hysterectomy and found higher odds of complications among patients receiving neoadjuvant chemotherapy [32]. Together, these studies show that the perioperative profile varies with comparator, patient

Table 2 presents a narrative synthesis of the findings across clinical outcome domains, including perioperative and oncologic outcomes, procedures for locally advanced disease, the learning curve, recovery and quality of life, comparisons between robotic and laparoscopic surgery, and the feasibility of sentinel lymph node procedures. Overall, the studies suggest potential perioperative benefits of robotic surgery in certain contexts; however, oncologic findings were heterogeneous and do not establish a general survival advantage. Interpretation should also account for differences in study populations, designs, follow-up periods, and care pathways. Outcomes were summarized descriptively, and no quantitative pooling was performed.

characteristics, and treatment context.

Oncologic findings were inconsistent across the comparative cohorts. Some reported no statistically significant adjusted survival differences [15, 17, 19-20], whereas others reported poorer progression-free survival (PFS) or disease-free survival in robotic groups [22, 27]. The multicenter cohort by Ponce *et al.* found recurrence in 26 of 239 patients and identified tumor size, histology, nodal status, tumor grade, and sentinel-node biopsy as prognostic factors within a robotic cohort [31]. These findings should be interpreted in light of variation in stage, tumor size, surgical experience, and follow-up across the included studies [15, 17, 19-20, 22, 27, 31].

The LACC trial, the population-based cohort by Melamed *et al.*, and the SUCCOR study inform the broader question of minimally invasive radical hysterectomy, but they do not provide a robot-specific causal estimate [1-3]. Their findings should therefore be considered separately from studies that directly identify robotic outcomes. The absence of a robot-specific estimate in those landmark studies remains relevant when interpreting the mixed results in the robotic cohorts.

Studies after neoadjuvant chemotherapy or chemoradiation

describe technical feasibility in selected patients, while learning-curve cohorts associate institutional experience with recurrence or disease-free survival [10-11, 16, 21, 23, 25, 32]. These findings place surgical experience and case selection within the clinical interpretation of reported outcomes; they do not support an assumption that the robotic platform alone determines prognosis.

The 2025 single-center pilot by Oplawski *et al.* adds a contemporary description of robotic radical hysterectomy, total mesometrial resection (TMMR), and trachelectomy in early-stage cervical cancer [33].

Across outcome domains, GRADE certainty remained low for comparative perioperative blood loss and length of stay because the direction of findings was broadly similar across several sizeable cohorts, while residual confounding and heterogeneous outcome definitions prevent higher certainty. Certainty was very low for complications, pathologic outcomes, recurrence and survival, patient-reported recovery or quality of life, and technical feasibility. These ratings reflect residual confounding, inconsistent findings, limited or unequal follow-up, sparse events, indirectness, and the absence of concurrent comparators in single-arm studies. They describe confidence in the body of evidence and do not imply a pooled effect estimate [5, 7-9].

The prospective study by Baeten *et al.* found that robot-assisted sentinel lymph node detection with a drop-in gamma probe was feasible in ten patients, with at least one node detected in every patient and no procedure-related adverse events. This evidence contributes to the assessment of robotic procedural capability but addresses mapping feasibility rather than long-term cancer control [30].

5. Conclusion

This systematic review synthesized perioperative, pathologic, oncologic, and recovery outcomes reported after robot-assisted surgery for invasive cervical cancer. Across the 24 included studies, some observational cohorts reported lower blood loss, shorter hospitalization, or faster recovery; however, operative time, complications, pathologic findings, recurrence, and survival varied across studies and comparators. The evidence therefore suggests possible perioperative benefits in selected settings but does not establish oncologic equivalence or superiority over open surgery or conventional laparoscopy. Given the predominantly nonrandomized designs and clinical heterogeneity, these findings should not be interpreted as causal effects of the robotic platform, and results from studies combining robotic and conventional minimally invasive procedures cannot be attributed specifically to robotic surgery.

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